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Rodenburg, C.A.; van Leeuwen, E.S.; Nijkamp, P.

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# A Comparative Framework of Assessment Indicators for Urban Green Spaces

Research Memorandum 2002-27

Faculteit der Economische Wetenschappen  
en Bedrijfskunde (FEW&B)

Vrije Universiteit

Amsterdam





# **A Comparative Framework of Assessment Indicators for Urban Green Spaces**

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**Caroline A. Rodenburg  
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Peter Nij kamp**



# A Comparative Framework of Assessment Indicators for Urban Green Spaces

A case study on Dutch cities

Caroline A. Rodenburg  
Eveline S. van Leeuwen  
Peter Nijkamp

*Free University Amsterdam*  
*Department of Spatial Economics*  
*The Netherlands*  
Email: [crodenburg@feweb.vu.nl](mailto:crodenburg@feweb.vu.nl)

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Abstract

The urban built environment does not only comprise **artefacts** made up of concrete and asphalt, but **also** man-made green **areas**. This paper aims to present a general framework for the evaluation of urban green **structures** and green **spaces**. It is a **result** of the EU project ‘Development of Urban Green Spaces to Improve the Quality of Life in Cities and Urban Regions’ (URGE)<sup>1</sup>. The **objective** of the project is to **provide** a **systematic** and operational assessment **framework**, which contains methods and measures of green **space** development and management in cities. The **main** question is **how** urban green **spaces can** be developed and managed and which evaluation **tools** and instruments are **helpful** in this framework. There are four complementary perspectives in this project from which urban green **spaces** are analysed: ecological, **economic**, **social** and planning. The present paper offers mainly a **functional** typology of urban green **spaces** according to **economic aspects** as the basis for the determination of the dimensions, criteria and indicators that are relevant for the assessment of urban green **spaces**. The methodology is applied to cities in The Netherlands on the basis of various empirical data. The representation of **contrasts** and commonalities in different **categories** of cities is based on the so-called spider model. In this way, an **economic** assessment of Dutch cities **will** be offered **from** which policy conclusions are drawn.

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<sup>1</sup> The project is **funded** under Key **Action 4** ‘The City of **Tomorrow and Cultural Heritage**’ of the **Programme** ‘Energy, **Environment** and Sustainable Development’ of the 5<sup>th</sup> **Framework Programme** of the **European Union**.

## 1. Introduction

The modern **world** is in a continuous **process** of rapid urbanisation. This **holds** for all **countries** with industrial regions taking the lead. The United Nations forecasts that by the year 2025, more than 60% of the world's population **will** be living in urban **areas**, compared to 29% in 1950 (Sukopp, 1998). **Such** developments lead to a **call** for sustainable development. Since the World Commission on Environment and Development launched 'Our Common Future', sustainability has become an important political issue (World Commission on Environment and Development, 1987). The aim of this policy document is by **nature rather** general and global. For proper implementation of the policy recommendations, they must be translated into concrete **action** plans at a decentralised **level**, **such** as local communities. At the European **level**, the Sustainable Cities and Towns Project helped formulate a set of guidelines for sustainable local development based on comprehensive urban ecological research. A large number of cities adopted the **principles when** they convened in **Aalborg, Denmark**, in 1994 (European Commission, 1996).

The present paper is part of the URGE project which is **funded under** Key **Action 4** 'The City of Tomorrow and **Cultural Heritage**' of the Programme 'Energy, Environment and Sustainable Development' of the **5<sup>th</sup>** Framework Programme of the European Union. The URGE project is related to the aforementioned policy issues about proper implementation of guidelines for sustainable development. Within the URGE project team, urban green **spaces** are considered as an important contribution to the sustainable development of cities. The research group recognises the potential of green **spaces** to improve the quality of urban life, but is **also** aware that this potential is hard to realise, as **current** management **practices** are **often** far from optimal. Therefore, the project includes the elaboration and testing of an interdisciplinary **catalogue** of methods and measures, based on experience **from** various European cities. This **catalogue** comprises criteria to **evaluate** ecological, **economic**, sociological and planning issues. The participating cities **will each** select two green **spaces** that **will** be used as case studies, by **means** of which to test the applicability of the criteria. The comparison of the results of these analyses **will** enable the research team to evaluate the relevant green **spaces**, according to their contribution to the quality of life in urban **areas**. This **will** allow conclusions to be drawn about the effectiveness of national and regional **policies** and their implementation. The knowledge gained **will** be **used** to improve existing green **spaces** and to optimise urban green **policies** in Europe (URGE, 2001).

This paper addresses **also** the question why people are interested in urban **green spaces** from an **economic** point of view. It is therefore that **economic** indicators have been developed, to give us proper information **to discover** the order of magnitude of **demand** for and supply of the multi-faceted **functions** of various urban green **spaces**, **resulting** in the **economic** value of urban green **space**. The **economic** value of **nature** **can** be **defined** as the total amount of welfare that **nature** generates for society. These are not **just** financial **measures**. One **can** distinguish **economic** values and **financial** values. Financial values **indicate how much** one must **pay** for a good in the market (market **prices**). **Economic** values, on the other hand, **also** take into account externalities (both positive and negative) that do not involve money transfers. The **economic** criteria and indicators represent both **economic** and **financial** values of urban green and are represented by **four** distinct **economic** dimensions of urban green, as **will** be shown later in this paper.

This paper is organised as follows. The next section describes the definitions that will be used in this paper. Section 3 deals with economic dimensions, criteria and indicators. In Section 4, the spider model will be introduced as a meaningful analytical and operational tool, whereas in Section 5 this spider model will be applied on 24 Dutch cities, illustrating the presence and importance of urban green in different city types. The policy relevance and conclusions are offered in Section 6.

## 2. Definitions of Terminology Used

The urban environment is complexly structured and richly textured in its interweaving of a mixture of natural, built-form, economic, social and cultural dimensions (Haughton and Hunter, 1994). Therefore, the overall urban environment can be said to consist of natural, built and social components. The natural environment includes air, water, land, climate, flora and fauna, whereas the built environment contains the fabric of buildings, infrastructure and urban open spaces. The social environment embraces less tangible aspects of urban areas, such as aesthetic and amenity quality, architectural styles, heritage, and the values, behaviour, norms and culture of the resident community (OECD, 1990). This seems to be closely related to the classification used in the URGE project: ecological, economic, social and planning. To become 'green', Haughton and Hunter (1994) argue that cities should not just clean themselves up, they need to become life enhancing and regenerative to secure reciprocity between the urban way of life and the natural web that surrounds it. Key ingredients in creating a green city are the need to look at the city in its bioregional context, and to bring about fundamental changes in the ways in which people treat nature, and treat each other.

A clear definition of urban green space is essential for the creation of relevant economic indicators. Since this paper is related to the URGE project, the definition of urban green space that is used in this paper is almost similar to the one that is used within the URGE project. The aim of the URGE project is to improve the future management of green spaces in cities and urban regions by providing methods and procedural guidelines for the inclusion of ecological, social and economic factors in the process of urban planning and maintenance. The definition used in the URGE project has been formulated by ecologists, economists, social scientists and planners, and they agreed on the following definition:

*By urban green spaces we understand public and private open spaces in urban areas, primarily covered by vegetation, which are directly (e.g. active or passive recreation) or indirectly (e.g. positive influence on the urban environment) available for the users.*

Green areas can be privately owned or an entrance fee can even be charged for access to them (such as is the case for botanical gardens etc.), as long as they are available for public use. Since the URGE project is mainly focussed on the residents of a city, tourist use is not relevant for URGE. The colour (i.e. urban blue, urban brown, etc.) is also essentially irrelevant. The importance of urban green lies in public access. Cemeteries and allotments are excluded. These could, however, be considered if they are mainly used as parks or recreation areas. Trees in streets and other small green features are generally excluded (they are not green "space"), but may be regarded on a city scale as part of the green structure (URGE, 2001).

As mentioned above, the **definition** of urban green space **used** in this paper is **almost similar** to the URGE definition. The most important **difference** is that this paper **also refers** to natural **areas** and forests within the boundaries of the municipality **when** using the term 'urban green space'. Reason for this is the availability of interesting data on this category of urban green space with which the analysis by **means** of **economic** indicators **may** be enriched. **When** we focus on the availability of urban green, we **also** include recreation **areas**, both for daily recreational activities and for extended stays. We think that these functions and activities **all contribute** to urban sustainability and the **quality** of life in the city.

### 3. Economic Dimensions, Criteria and Indicators

Improving the environment by **means** of **economic** instruments has been increasingly recognised in recent years. **Also** Agenda 21 **from** the 1992 Rio Earth Summit **summarises many** of the **benefits** of **economic** policy approaches. There is a particular value to looking at **economic** instruments in an urban context, since **many** of the environmental problems of cities **relate** to what economists **would** refer to as a concentration of negative externalities, that is, non-costed environmental impacts (Haughton and **Hunter**, 1994). The use of **economic** instruments to improve the urban environment is rapidly evolving.

**Economic** criteria and indicators **can** be a **very helpful** tool for evaluating urban green spaces. First of **all**, criteria that determine **functions** of urban green **spaces** should be formulated. Secondly, indicators should be developed in order to measure and **quantify** the criteria. Indicators are pieces of information designed to **communicate** complex messages in a **simplified**, (quasi-) quantitative **manner** so that progress in the field of **decision-making** **can** be measured (Rothmans, 1997). The indicators **can** be measured with the help of necessary quantitative input. This necessary input consists of data that must be **collected** by, for example, statistical analysis, **or** quantitative and qualitative **surveys**. Indicators are bits of information that highlight what is happening in the **large** system; they are **small** windows that **provide** a glimpse of the 'big picture' (Kuik and **Gilbert**, 1999).

Indicators have three **functions**: (1) simplification (to simplify information about complex phenomena), (2) (quasi-) quantification (to **quantify** information so its **significance** is more readily apparent) and (3) communication (to improve communication of the information to the user) (van Delft, 1997, Rothmans, 1997). The additive 'quasi' **indicates** that, in **principle**, indicators **could also** be **qualitative**. Qualitative indicators **may** be preferable to quantitative indicators **where** the underlying quantitative information is not available, **or** the subject of interest is not inherently **quantifiable** (Gallopín, 1996).

Indicators are a **compromise** between **scientific** accuracy and the **demand** for concise information. The **basic** challenge for indicator development is: 'to **reduce** a **large** quantity of data down to its simplest form, retaining essential meaning for the questions that are being asked of the data' (Kuik and **Gilbert**, 1999). Good indicators present information in a **clear** and **usable** form at the right **time** to those **who** need it (Boyd, 1997). Different users of environmental indicators have different **needs**. Thus the appropriate set of indicators depends on its **particular** use. Therefore it is important to determine the users of this project. The users in the **short** term are the project partners of URGE. In the long run, the users **will** be urban authorities and municipalities. To **generate** discussion among these people **having** different

backgrounds and viewpoints, and to help create a shared vision of what the community should be, indicators can be a useful tool (Sarmiento et al., 2000). A logical starting point in the development of economic indicators for urban green is the development of a functional economic taxonomy of urban green spaces. This forms the basis for determining the economic value of urban green spaces. Which functions are most relevant for a given urban green space depends on the ecological characteristics, the cultural and socio-economic setting, and the management objectives of the area in question (de Groot, 1994). The determined functions have been classified into four economic dimensions of urban green spaces. These are successively the socio-economic dimension, the environmental dimension, the merit dimension and the financial dimension. The classified dimensions and the accompanying functions are shown in Figure 1.

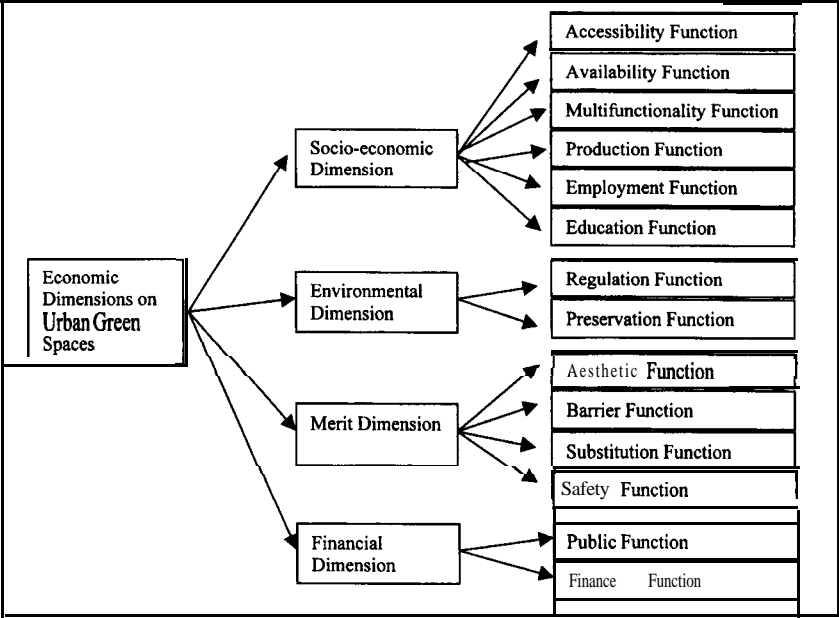


Figure 1: Four economic dimensions on urban green spaces with their matching functions (Rodenburg et al., 2002)

The socio-economic dimension contains the functions that have an impact on welfare and quality of urban life aspects, for example, the employment function or the education function. The environmental dimension refers to scarcity elements that are linked to the physical surroundings and the environment, for example, the regulation function. The merit dimension shows the virtue of urban green to the residents. It concerns external effects that are useful to the visitors, for example, the barrier function when the vegetation works as a windbreak or noise barrier. The financial dimension is related to the way of financing urban green and the importance of urban greento the local authorities (Rodenburg et al., 2002).



4. Use of the Spider Model

The **economic** dimensions on urban green space serve as either signposts for **policy-making** or as **quantified** tools for **comparative** analysis. As an analytical **tool** for our analysis, we **will** employ here the so-called spider model (see Rienstra, 1998). Spider models **can** be used to visualise the relative **strengths** and weaknesses of the selected case studies for various **chosen** factors. **Each** factor is represented by an axis starting **from** the interior towards the outer boundary of the spider, in which the lowest scores are to be found in the **centre** of the spider. The score of **each** factor is based on quantitative data, standardised on a ten-point **scale**. It should be stressed that there is no weighing between the factors. A straightforward numerical comparison of scores related to different factors is not allowed. A score of 7 on one factor does not necessarily **mean** that it is a better score than a score of 6 on another factor. The envelope **composed** of **all** scores per factor forms a connecting line resulting in a surface representing the integral representation of these factors per city type. In **general**, one might **state** that the larger the surface, the better the city type in question scores. The advantage of this visualisation by **means** of the spider model is that it is easy to show the relative score of the various city types concerning urban green. The starting point of this analysis is that the larger the area of usable public urban green space **available** to the household, the better it is for health, privacy, recreation and development. In addition, the lower the density of residential use the better (OECD, 1978). For the **economic** assessment of the Dutch cities data **from** the **Statistics Netherlands** was used. For twenty-four different **municipalities**<sup>2</sup> several variables concerning demographics and land use were used for the analysis (see van Leeuwen et al., 2002).

Most of the cities are selected on the basis of the number of inhabitants with a minimum of 100.000 inhabitants. A few municipalities count fewer people within their borders; **however**, because of their **importance** for the **province** or region they are included in the analysis. Middelburg, for example, counts only 44,920 inhabitants but it is the most important city of the **province** of Zeeland. The twenty-four cities **can** be divided into four groups (see van Leeuwen et al., 2002): Big cities **(4)**, New cities **(4)**, Intermediate cities (8) and Peripheral cities (8) (see Table 1).

Table 1: **Four groups** of cities

<i>Big Cities</i>	<i>New Cities</i>	<i>Intermediate Cities</i>	<i>Peripheral Cities</i>
Amsterdam	Almere	Breda	Deventer
Rotterdam	Alpen aan de Rijn	Ede	Den Helder
The Hague	Zaanstad	Eindhoven	Emmen
Utrecht	Zoetermeer	s'-Hertogenbosch	Middelburg
		Leiden	Roermond
		Nijmegen	E n s c h e d e
		Tilburg	Groningen
		Zwolle	Maastricht

Source: van Leeuwen et al., 2002

*The big cities* are relatively old cities, which form the Randstad, the highly urbanised region in the western part of The Netherlands. They have the highest population and

<sup>2</sup> **Statistics Netherlands** provides data about **municipalities**. This implies that in some cases not only the cities are taken into account **but also** the smaller **villages** that are administratively **related**.

housing density. A high percentage of ethnic minorities live in these cities and the **average** discretionary income per household is relatively low. This **goes often** together with a high unemployment **rate**. The new cities are situated near the big cities and are built **or** expanded because of the pressure on, for example, the housing market in the big city. **Also** the people **who** do not prefer to live within a big city but **who** want to live nearby because of their work live in new cities. There are **quite** some differences between the big and the new cities. The population of the new cities is relatively young, **many children** under 15 and less people above 60 years old. The unemployment **rate** is **very low** in the new cities and the **average** discretionary income is relatively high. The housing density and the population density are **much lower** compared to the big cities. *The intermediate cities* show intermediate scores on the different variables, although the housing density as **well** as the population density are relatively high. The *peripheral cities* are **often** smaller cities situated in peripheral **areas** with an important regional function. They are the biggest city **or** sometimes even the only city within their region. Because of their situation in the peripheral **areas** the housing and population density is low. These cities **often** have a **small** percentage of ethnic minorities and a larger number of elderly.

5. Application of the Spider Model

The above **discussed** spider model **will be applied** to the data that are **collected** for the 24 Dutch cities. We have tried to get complete information on all four **economic** dimensions of urban green (socio-economie, environmental, **merit**, and **financial**). Unfortunately, we **faced a lack** of data, especially concerning the **merit** and the **financial** dimension. Therefore, the analysis so far will mainly be based on data representing the socio-economie and environmental dimension. Figure 2a presents the socio-economie data for the four city groups, weighted for the **size** of the population (number of inhabitants).

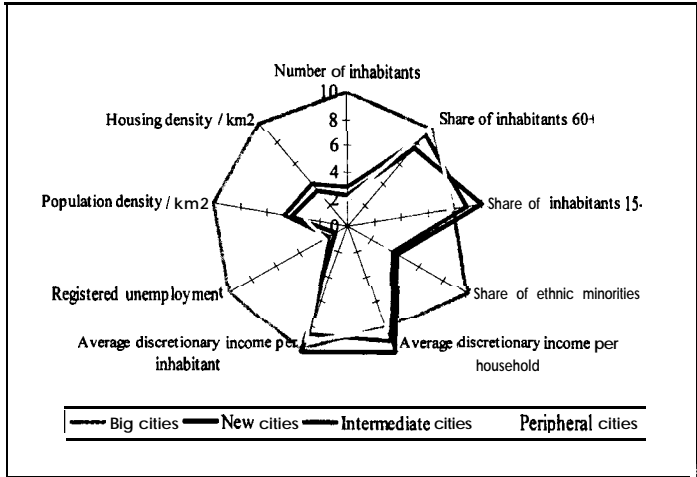


Figure 2a: General representation of the four City groups on the basis of socio-economic indicators

Not surprisingly, in this **figure**, the big cities have, on **average**, the highest scores on the socio-economie dimension, **except** for the share of inhabitants over 60 years old, the share of inhabitants younger that **fifteen** years old, and the **average** discretionary income per household and per inhabitant. Since the new cities count **many** young families, they have the highest score on the share of inhabitants younger than 15 years old. These cities **also** represent the highest discretionary income per household and per inhabitant, due to the **fact** that in **many** families in new cities both adults have a job. This could be the explanation for the low score on registered unemployment. The peripheral cities, on the other hand, have the highest score on the share of inhabitants over 60 years old, since they attract **many** retired people.

Next to the presentation of the four city groups, it is interesting to have a look at the scores of the different cities within a city group. An example is given in Figure 2b. It shows the scores of the peripheral cities on the socio-economie indicators. **Except** for some extreme values for Maastricht and Groningen (being the largest peripheral cities (capitals of their **province**), which explains the high scores on population and housing density), the **average** shape of the lines corresponds with the shape that represents the peripheral cities in Figure 2a.

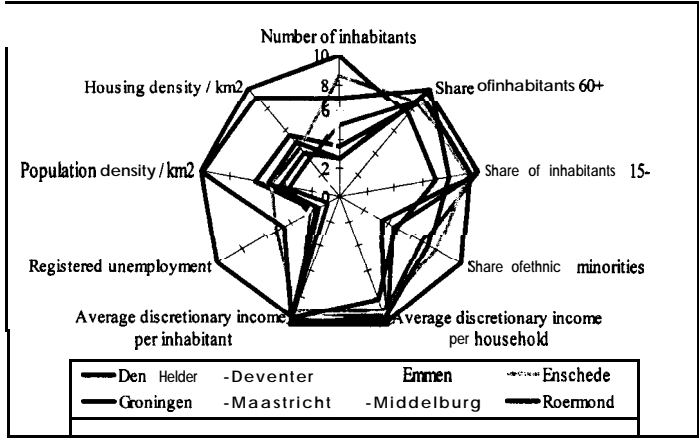


Figure 2b: General representation of the peripheral cities on the basis of socio-economic indicators

Apart from the general socio-economie information as shown in Figure 2a and b, the spider models are an interesting tool to show other differences between the four city groups as well. The further analysis **will** be **focussed** on the availability and distribution of urban green in those city groups, representing the environmental **economic** dimension.

Figure 3a shows the different kinds of land use that **can** be found within the city groups as a percentage of the total area of the city groups. This spider model shows **much** more variety than the spider model in Figure 2a. Here, the big cities do not represent the highest scores on **almost all factors**. **Factors** on which they do have a high score are the total area of the city as **well** as the total built up area. The total area of the other three city groups is smaller, but not **much** different from **each** other. **However**, concerning the share of the total built up area there is **much** more variety. The new cities have the **smallest** share of built up area, but represent the highest share

of housing within the built up area. This is not surprising, since these cities are mainly developed as an expansion of big cities because of the pressure on, for example, the housing market in the big city. Furthermore, it becomes **clear** that, **also** not surprisingly, the peripheral cities **often** have **quite** some **agricultural** activities within the municipality, whereas the intermediate cities have **many nature** and forest **areas** compared to other city groups. It is striking that the new cities have a **large** water surface compared to the other city groups. There seems to be a tendency that if cities have **many** forest and **nature areas**, they **almost** have no water and vice versa (intermediate vs. new cities). There are two possible explanations for this tendency: (1) it is easier to **provide** new to built cities **with** water than with forests (new trees take ages to develop into a **real** forest), and (2) the new cities are mainly to be found in the western part of the country which is the wet part. Furthermore, a combination of forests and water **areas** within a city does not go without saying, since forests prefer **dryer areas** and are therefore mainly to be found in the dry **areas** of The Netherlands.

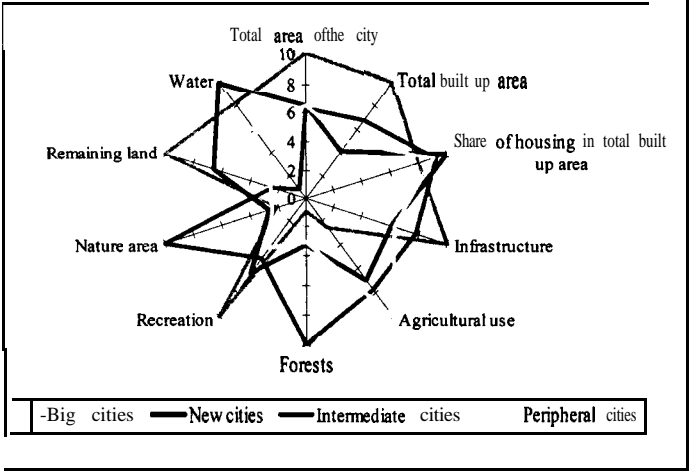


Figure 3a: General land use within the four city groups

Figure 3b shows the scores of the big cities on general land use within the cities. Especially Amsterdam and Rotterdam seem to be responsible for the scores on the **left side** of the spider, whereas Den Haag and Utrecht seem to be responsible for the scores on the **right side** of the spider. **All** four cities have a high score on recreation, which is directly reflected in the integrated spider in Figure 3a.

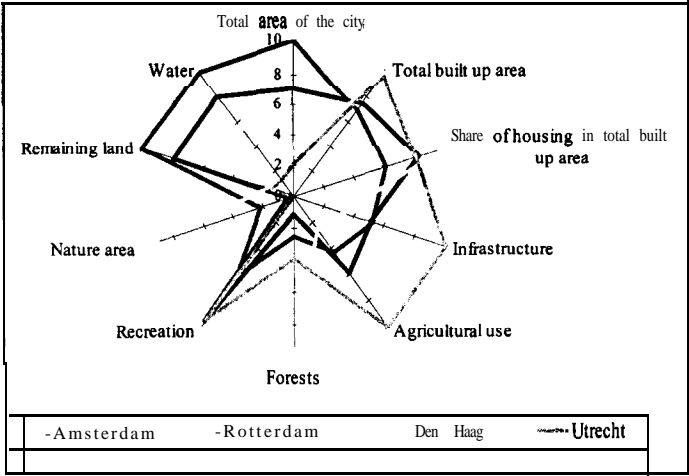


Figure 3h: General land use within the big cities

The general land use can even be split up further into specific types of green land use within the four city groups. Figure 4a shows the different types of urban green areas within the four city groups in hectares per inhabitant. The total area for recreation purposes as well as the total nature area has been split up into sub-groups. This figure is very illustrative, since it immediately shows that the big cities have a very low share of different types of urban green per inhabitant. The new cities have much park area per inhabitant as well as the best opportunities for day recreation, whereas the intermediate cities have the best opportunities for longer stay recreation. It is striking that the peripheral cities, with their relative high share of inhabitants over 60 years old, have a relatively higher share of sporting fields per inhabitant than the new cities, with their relatively high share of inhabitants younger than 15 years old.

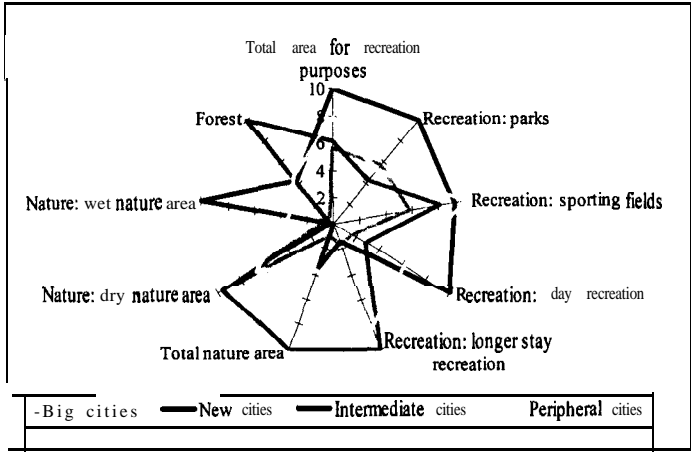


Figure 4a: Green land use within the four city groups

A comparison between Figure 4a and Figure 4b shows that the high scores of Almere on total **nature** area, forest, and **longer stay** recreation are not represented in Figure 4a. This individual share does not seem to be enough to outweigh other city groups on these factors. The emphasis is in this spider model (Figure 4b) on the right hand **side**: parks, sporting **fields** and day recreation. These are **also** the factors on which the new cities have a high score in the spider model representing the four city groups (Figure 4a).

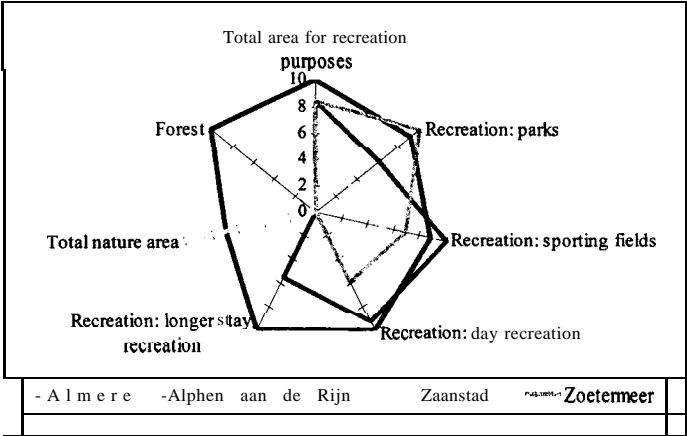


Figure 4h: **Green** land **use** within the **new** cities

The available data on the environmental dimension of urban green (Figure 3a and 4a) could be divided into two **categories**: **human-made areas** and natural **areas**. Analysing the data **from** this point of view results in the conclusion that especially the big cities have a high score on the human-made factor as a percentage of the total area of a city (Figure 3a). The **natural areas** (**nature**, forest, and **agriculture**) are mainly represented by the other city groups. **However**, if we have a look at the area of human-made urban green per inhabitant (Figure 4a), the big cities have a **very** low score. The explaining variable for these two different scores could be the **very** high population density in big cities.

**After having** analysed the socio-económie and the environmental **economic** dimension separately, it is interesting to see what the spider **models** will show **when** we combine those two **economic** dimensions of urban green.

First of **all**, we had a look at the combination of socio-económie indicators and the **general** land use indicators of the environmental dimension. Figure 5 shows that a high population density and a high housing density **often** go together with a **very** low share of agricultural land use and **nature** and forests, but **also** with an abundance of recreation **areas**. On the other hand, there seems to be a clear relation between a lower population and housing density and the presence of agricuhural land.

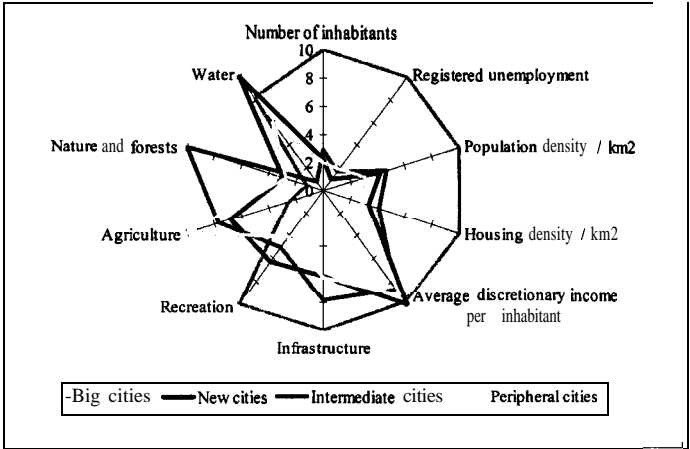


Figure 5: Socio-economic dimension versus environmental dimension (general land use)

If we make another combined analysis of socio-economic and environmental economic indicators on a lower, more detailed level, showing the kind of urban green land use per inhabitant within the different city groups (Figure 6), we see that there is quite some similarity in patterns. Many cities have common visualisations, except for one or two indicators, which, however, are no real explanatory factors. This spider model nicely illustrates that a very high housing and population density goes together with a very low availability of natural areas and forests per inhabitant.

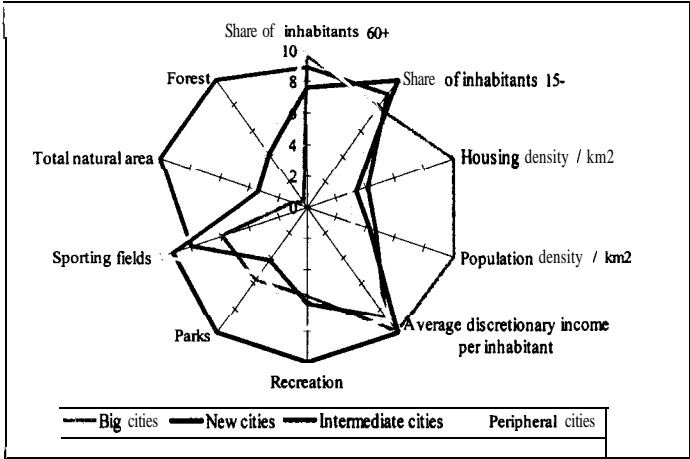


Figure 6: Socio-economic dimension versus environmental dimension (green land use)

In the next section, the policy relevance and the general conclusions that can be drawn from these spider models will be described.

## 6. Policy relevance/conclusions

Cities **can** be recognised as the **centre** of **economic** growth, **human** civilisation and places were **cultural** and commercial ideas are born. But cities are **also** places which put a heavy burden on the environment and which **can** have an unhealthy climate for the population. Therefore a concern has emerged for the concept of sustainable cities: cities which aim to meet the **needs** of the current population in an efficient and responsible **manner** without reducing the opportunities for the next generations. The use of urban green is a new, but important topic of social science research work. With help of **economic** dimensions we tried to evaluate cities and their urban green **spaces**. In this paper we **focussed** especially on the socio-economic and the environmental dimension of urban green **areas**.

The analysis by **means** of the spider **models** showed interesting results. A **final** conclusion of the **economic** assessment on the twenty-four Dutch cities is that, **when** focussing on the availability of green **areas** in and directly around the cities, the big cities show the lowest scores on the availability of urban green within the municipality. They **accommodate** less green **spaces**, especially less natural green **spaces**, not only as a percentage of the total land use, but **also** concerning the availability per inhabitant. **However**, since big cities have a high population and housing density the availability of urban green **spaces** might even be more important than in other city types. Therefore, more attention should be paid to the analysis of urban green **spaces** in (big) cities with high population and housing densities. **Such** an analysis should not only focus on the availability of urban green **spaces**, but **also** on the **importance** of urban green **spaces** for the inhabitants of cities.

Regarding the research limitations of an application of the **economic** dimensions on planning **processes**, the **first** problem that we have **faced** in applying this framework to Dutch cities is to **collect** relevant data. The **difficulties** in collecting data stem **from** both a **lack** of data, and the classification **categories or** different measures that the cities used, creating **difficulties** in comparison. Another problem related to data collection is the administrative **structure** of the cities. The **existence** of several urban administrations within the city requires collecting data **from** different sources, which is a **very difficult** task. These difficulties decrease with the **willingness** of the urban administrations to **participate** in these kinds of **projects**.

The next steps of the URGE project **will** include the combination and integration of the various criteria and indicators belonging to the various dimensions of the different perspectives used in the project (ecological, **economic**, social and planning). Some of them **will** overlap, others won't, but it **will** be necessary to deploy them unambiguously. These integrated criteria **will** be used in a case-study approach to European cities to **create** the necessary information. In this experimental stage they **may** face various difficulties, even contradictions, which **may** then lead to the necessity to improve the criteria and indicators used so far. **However**, this experience **will provide** an opportunity to develop a common language among the different disciplines in green planning and management.



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